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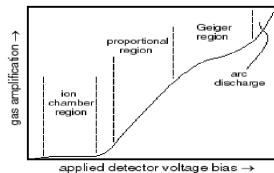
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Introduction

- LArTPC (Liquid Argon Time Projection Chamber) as a TPC is an application of proportional and drift chambers.
- PROPORTIONAL CHAMBERS work on the proportional region, i.e. $|\vec{E}| \approx 10^4 \text{ ev}$. The output signal is proportional to the energy of the particle.

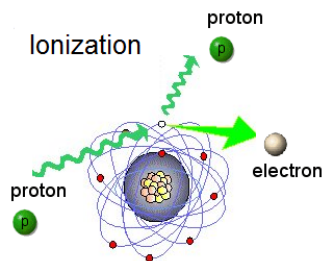
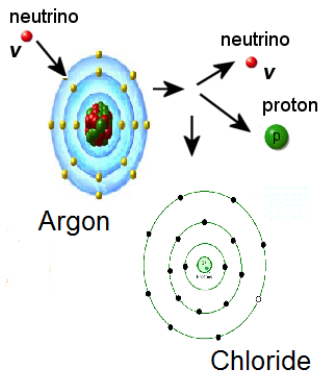


- DRIFT CHAMBERS use the fact that the liberated electrons take time to drift from their point of production to the plates.

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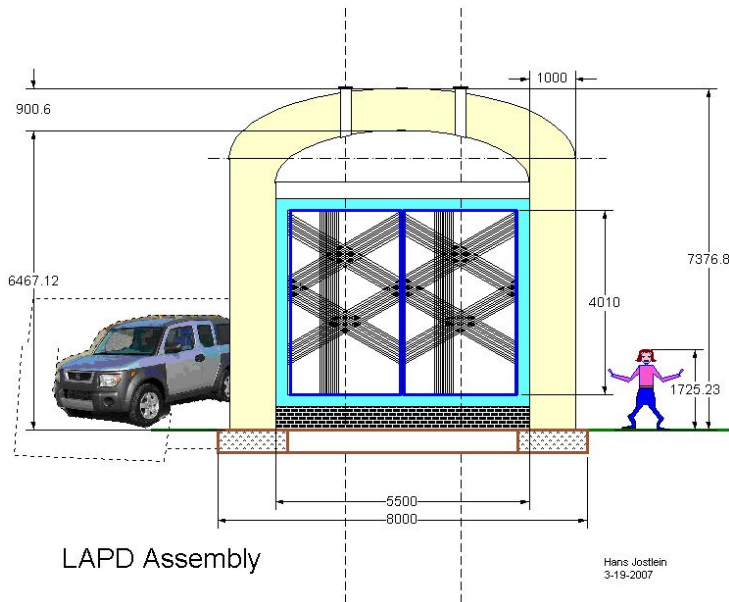
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Particle interaction



Introduction

- Why using Liquid Argon?
 1. Is not expensive and it is easy to get it
 2. It is a inert gas
 3. It is easily ionizable.
 4. Using Ar on its liquid form increases the cross section of the interaction.
- Because Oxygen constitutes aprox. 20*percent* of the air, we have to make sure that the O_2 does not exceed 20ppt (parts per trillion) because it may eat the liberated electrons, thus, introducing noise to our measurements.
- In the past, taking a vessel down to vacuum has solved this problem; however, evacuation is impossible for the massive tank sizes.



Hans Jostlein
3-19-2007

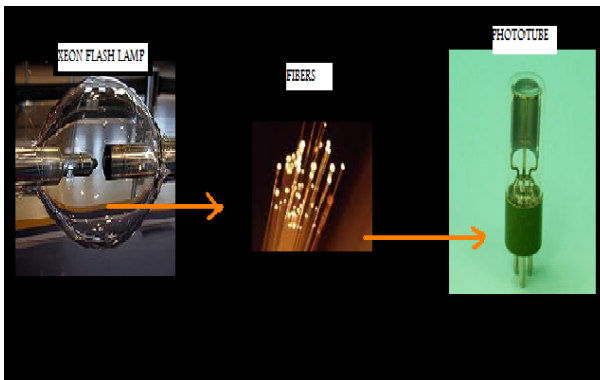
Steps for the test

- The proposal is that the evacuation is not needed, instead we will use an argon piston.
- TEST
 1. In order to remove the oxygen and water, Argon gas will be introduced in the bottom of the chamber, pushing the lighter atmosphere to the top of the vessel where some valves will be located. Gaseous argon will be circulating till the purity level is achieved (50 parts per million).
 2. Once we achieve this purity the LAr will be introduced and will be circulating till we have 100 parts per trillion.
 3. Then, all the structural components will be put in place.
 4. TPC will be installed and some measurements will be done in order to prove that the effort was successful.

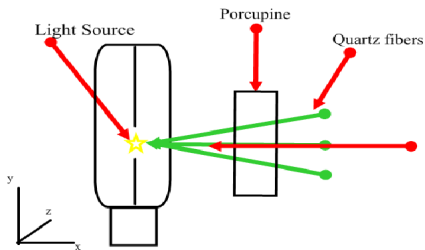
Purity Monitor

- HOW DO WE MEASURE HOW PURE OUR ARGON IS?

Purity monitors measure purity by firing a light pulse from a xenon lamp at a photocathode and then drifting the ejected electrons to the anode with an electric field. The number of electrons surviving the transit from the cathode to the anode gives a measure of the argon purity.

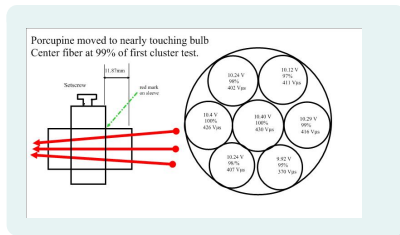
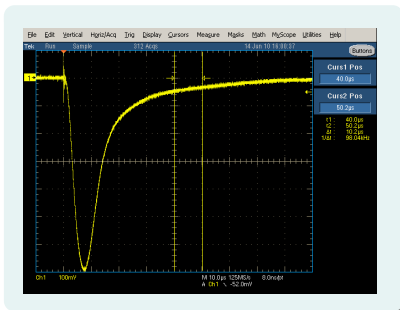


- Since a large-scale argon purification system will be designed and tested, we need to maximize the light capture from every single Xeon Flash Lamp.
- We used a device that holds and aims multiple fibers at a central focus.
- We constructed a test to measure the differences in the amount of light traveling through each fiber.



Conclusions

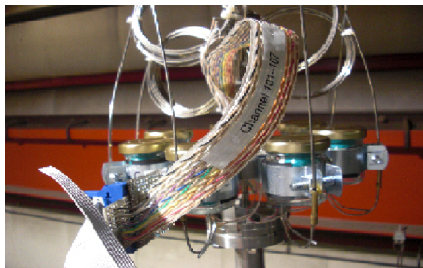
A graph and a scheme of our measurements. Using the scope we localized our peak in the middle fiber and then we measured the drop percentage in the other fibers



We can conclude that the outside fibers of the porcupine were within our target limit of 30 percent light loss .

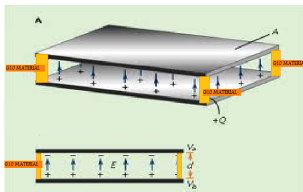
Oxygen sensors and Capillary

In order to study in detail the Argon gas purging process in a non-evacuated $15m^3$ tank, 14 sampling tubes will be installed in two bundles, one at the center and one at the edge of the tank. Each bundle will sample the oxygen content at seven different elevations (about 60cm apart) as Argon replaces ambient air in the tank. Each sampling tube connects to a separate capsule containing an oxygen sensing cell, which is read out continuously by a scanning system.



Introduction

- We need a material for setting up our structures inside the chamber. The distance between our plates is required to be the same.



- These materials should not affect the electric field inside the plates.
- G10 materials have extremely high strength and high dimensional stability over temperature.
- High resistivity is an important characteristic of these materials.

Discharge time

The structures need a resistance high enough to prevent current flow but to still allow some movement in a determined time in order to prevent charge build up.

- If we recall the formula for the discharge of a capacitor :

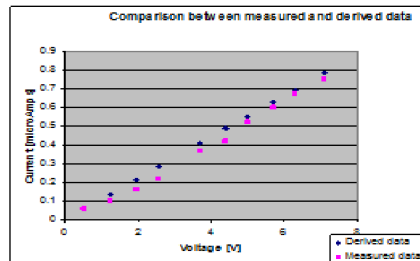
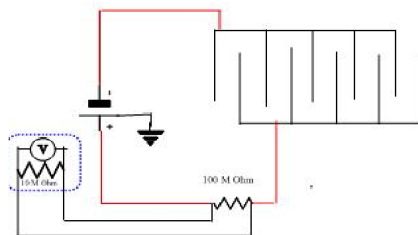
$$V(t) = V_0 e^{\frac{-t}{RC}}$$

Where : $\tau = RC$ is the time constant.

- The discharging process needs to be slow. This is why the Resistance is needed to be big.
- In order to have a stable discharging process, the internal properties of the materials should be as ideal as possible, that is why resistivity was tested.
- Because this materials will be under cryogenic temperatures we wanted to make sure that their properties remain constant or at least do not differ too much from the properties under room conditions.

G10

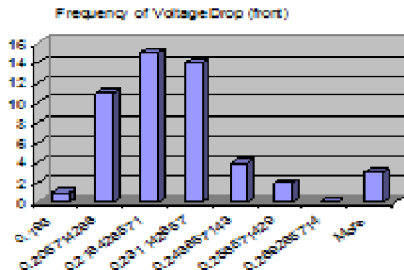
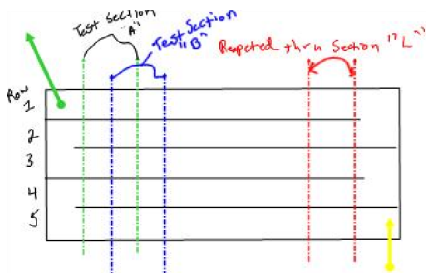
The circuit we followed, using a HPS (2500V). And a graph of our results.



The resistivity was found to be $1020 M\Omega \cdot m$ under room conditions. On the other hand, under cryogenic conditions we could not measure any specific voltage across the resistor.

ESD G10

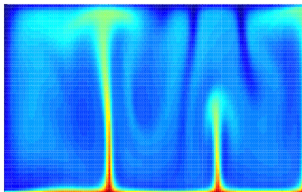
- We had a plate where saw cuts were made.
- We applied 5V to it.
- We constructed a test for measuring the resistivity, a scheme of this is shown here:



We concluded that the resistivity in this material is uniform. In this material the resistance doubled when we passed from room to cryogenic conditions.

Introduction

- When we have temperature gradients in a location of space, we expect to have heat transfer. One way of heat and mass transfer is convection.



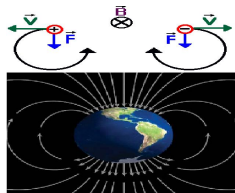
- Convection currents inside the chamber may change the electrons path and therefore our measurements.
- We need to make sure that these currents are not intense.
- In order to calculate the currents using a program we have to have the temperature distribution inside the chamber.

Objective

- In order to get the temperature distribution inside the chamber we need a device such that we can automatize the process.
- We also require precise coordinates of the place where we are taking measurements.
- We need to take several measurements at the same time.
- We need a device able to get precise measurement of cryogenic temperatures.

Introduction

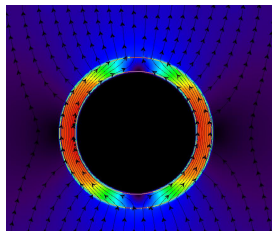
- $\vec{F} = q\vec{v} \times \vec{B}$



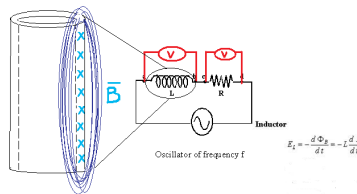
- The magnitude of the Earth's magnetic field is approx 30 – 60 *microTeslas*.
- But, how much does it affect to the electrons path?
 $\lambda = 280nm, \Phi = 3.3eV \Rightarrow K = hf - \Phi$
 $\Rightarrow v = 632143m/s$
After some basic kinematic formulas $t = 0.2ns$

Magnetic shields

The goal of this experiment was to make sure that the permeability of the material under cryogenic temperatures does not change.

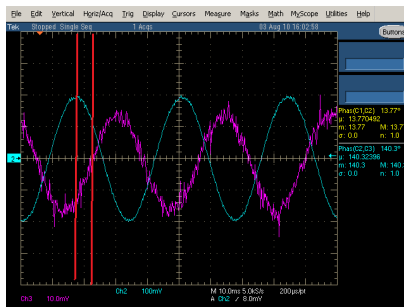


We tried to calculate the permeability of the shield by using the following technique:



Conclusions

The following graph shows the voltage across the resistor and the inductor. We can see a phase difference between them, which does not corresponds to what we should see.



We also tried to calculate the permeability using a transformer but we had the same phase difference problem. Therefore, we couldn't measure this property under different conditions.

Special Thanks

Special Thanks for making this a unique experience:

- Erik Ramberg, Roger Dixon, Eric Prebys.
- Carol Angarola, Amanda Petersen and Susan Q. Brown.
- Stephen Pordes, Hans Jostlein
- FUNDACION HERTEL
- To my little brother who told me about this.